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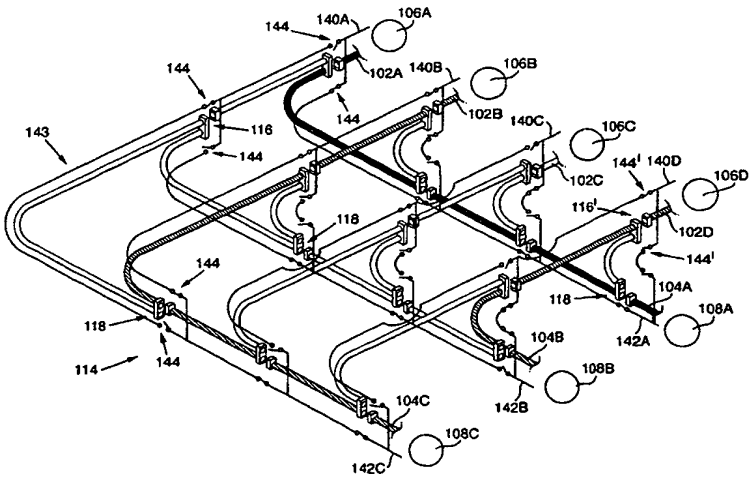

(57) Abstract

A conveying system for pneumatic conveyance of cigarette filter rods provides a matrix (114) of pneumatic conveying tubes (102, 104) and switches (116, 118) allowing filters to be delivered from any of a number of distributors (106) associated with different cigarette filter making machines to any of a number of receivers (108) at different cigarette filter assembling machines. The system includes pneumatic switches (116, 118) for selectively connecting pneumatic tubes at each junction, and corresponding commonly-switched electrical switches (144) for establishing electrical communication in accordance with the pneumatic connections. The pneumatic and electrical switching means may comprise a rotary or linear reciprocable switch element. In another system for transferring cigarette filter rods between groups of delivery devices and groups of receiving devices, pneumatic switches (64) are used to allow switching of rods from one group of delivery devices to another to supplement supply when required. A path length determination for rods conveyed pneumatically through a series of tubes may be made by detection of a sound pulse transmitted along the path of the rods through the tubes.

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Conveying Rod-Like Articles Pneumatically

This invention relates to systems for conveying rod-like articles pneumatically. Such systems are commonly used in the tobacco industry to convey filter rod lengths from a filter rod making machine (or a filter rod reservoir associated with such a machine) to a filter cigarette assembling machine, at which the filter rod lengths are cut and combined with wrapped tobacco lengths to form filter cigarettes. It is known to provide pneumatic distribution systems where a plurality of filter rod making machines are pneumatically linked for conveyance of filter rods to a plurality of filter cigarette assembling machines. In such systems electrical communication lines extend between the pneumatically linked machines, so as to allow control signals relating to the conveyance of filter rods to pass between the machines.

According to a first aspect of the invention a pneumatic conveying system for rod-like articles comprises at least one delivery device, at least one receiving device, means defining a pneumatic delivery path extending from said delivery device, means defining a pneumatic receiving path extending towards said receiving device, first switch means for selectively establishing connection between said delivery path and said receiving path, means for establishing communication between said delivery device and said receiving device including second switch means for selectively enabling signal communication in accordance with the status of said first switch means, and means for switching said first and second switch means. The first and second switch means may include a common switching element. Preferably said second switch means is associated with electrical communication lines extending between said delivery device and said receiving device. The electrical communication lines may include processing means such as a microprocessor. Preferably the system includes a control means for actuating said switching element in accordance with signals derived in dependence on occupation or passage of articles in the system. In a preferred arrangement there are a plurality of delivery and receiving devices and the paths and communication lines, together with the appropriate switches, allow any of the delivery devices to transmit articles to any of the receiving devices.

According to a second aspect of the invention a system for conveying rod-like articles pneumatically includes switch means having

means defining laterally-spaced passages for articles, means defining a further passage for articles, and operable means for causing relative movement of said means so as to align said further passage with a selected one of said laterally-spaced passages. Preferably the system includes an electrical connection associated with said switch means, wherein said operable means is arranged to cause switching of said electrical connection. In a preferred construction the relative movement is effected by reciprocable means, and may comprise linear and/or rotary components.

Where the operable means is rotary, in a preferred construction the system includes a first member having a first face and at least one of said laterally-spaced passages having an outlet in said first face, a second member having a second face and said further passage having an outlet in said second face, means for mounting said first and second members with said first and second faces substantially parallel and adjacent to each other and for relative rotational movement about an axis substantially transverse to said faces, said operable means including means for moving at least one of said members about said axis relative to the other so as selectively to move said member or members between a first position, in which said respective outlets in said first and second faces are in alignment, and a second position, in which said outlets are out of alignment.

According to another aspect of the invention a pneumatic conveying system for rod-like articles includes a plurality of delivery devices, a plurality of receiving devices, means defining paths for pneumatic conveyance of articles between each delivery device and at least one receiving device, and further means for conveying articles pneumatically between at least two delivery devices, whereby the supply of articles at one delivery device may be supplemented by receipt of articles from another delivery device. Preferably the system includes switch means for selectively connecting the output from a delivery device either to a receiving device or to another delivery device. In a preferred arrangement the delivery devices are arranged in groups of such devices with each group connected to a different source (e.g. a producing machine such as a filter rod making machine) and said further means comprises means connecting each group. The receiving devices may also be arranged in groups each associated with a different receiving machine (e.g. a processing machine such as a filter cigarette

assembling machine). In such an arrangement the receiving devices in each group are preferably connected to delivery devices in different groups.

According to a still further aspect of the invention, in a pneumatic filter rod conveying system (which may be in accordance with any other aspect of the invention) the length of a pneumatic conveying path for rod-like articles is determined, and the supply of conveying air is controlled in accordance with said determination. For example the pressure of the conveying air may be automatically adjusted on determination of a changed path length on alteration of switch settings to cause articles to be delivered to a different receiving device.

The path length determination may be made by a control system (e.g. including a microprocessor) in accordance with stored information, e.g. relating to locations of one or more switches and path lengths to or from these and the delivery and receiving devices. Alternatively, and in accordance with a further aspect of the invention, the path length determination is carried out by transmitting a sound (possibly comprising or including ultrasound) along the path and determining the path length from receipt of the sound (or an echo or other related signal) after passage along the path.

The different aspects of the invention may be embodied in common apparatus.

For convenience the invention will be hereinafter described with reference to conveyance of filter rods, hereinafter referred to as "plugs".

The invention will be further described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic view of a pneumatic plug distribution system,

Figure 2 is a perspective view of a switch employed in the system of Figure 1,

Figure 3 is a schematic view of a modified plug distribution system,

Figure 4 is a schematic view of a modified version of the system of Figure 3,

Figure 5 is a perspective view of a switch employed in the systems of Figures 3 and 4,

Figure 6 is an enlarged detail of the switch of Figure 5,

Figure 7 is a perspective view of a rotary switch which may be

employed in a pneumatic plug distribution system,

Figure 8 is an end view of the switch of Figure 7, viewed in the direction of arrow A in Figure 7,

Figure 9 is a side view of the switch of Figure 7, viewed in the direction of arrow B in Figure 7, and

Figure 10 is a plan view of a further modified plug distribution system.

Referring to Figure 1, a pneumatic plug distribution system is shown extending between five input tubes 2A-E and three output tubes 4A-C. The tubes are adapted to convey plugs pneumatically. Each of the input tubes 2A-E is connected to a channel 6A-E of a pneumatic distributor. The channels 6A-E are associated with plug making machines 8A-E. Although the channels 6A-E are each shown associated with a different plug making machine 8A-E, two or more channels could be associated with the same machine.

The output tubes 4A-C are connected to receiver channels 10A-C, each of which is associated with a plug assembling machine 12A-C. The channels 10A-C are each shown associated with a different machine 12A-C but two or more could be associated with the same machine. Each of the distributor channels 6A-E and each of the receiver channels 10-C may be of known construction, for example of the type available from the applicants as part of their Pegasus 2000 plug distribution system.

The input tubes 2A-E and output tubes 4A-C are connected by a matrix of further tubes 14 incorporating switches 16,18 for directing plugs between the tubes. The switches 16 allow passage from one inlet tube to either of two outlet tubes. The switches 18 allow passage from either of two inlet tubes into one outlet tube. The arrangement of tubes 14 and switches 16, 18 is such that, by appropriate selection of settings of switches 16 and 18, any one of the input tubes 2A-E can be connected to provide for passage of plugs to any one of the output tubes 4A-C. In a system similar to that shown in Figure 1 the number of switches necessary is obtained from the expression 2ab - (a + b), where a and b are respectively the numbers of inputs and outputs.

One of the switches 16 is shown in Figure 2. An inlet tube 14A is connected to a movable block 20 which is held in abutment with a fixed block 22 by means of a connecting link 24 and retaining springs 26. Two outlet tubes 14B and 14C are connected to the fixed block 22. (On

the side of the blocks 20, 22 not visible in the drawing there are two connecting links and a single retaining spring.) The block 20 is attached to a piston rod 28 operated by a double-acting pneumatic cylinder 30 attached by way of a trunnion mounting 32 to the fixed block 22 and a fixed frame member 34. In an alternative construction the movable block 20 is retained against the underside of fixed block 22 and slides in a substantially straight path between its alternate positions under action of the cylinder 30.

In the position shown in Figure 2 the inlet tube 14A is aligned with the outlet tube 14B. By operation of the cylinder 30, the block 20 may be moved so as to align the tube 14A with the outlet tube 14C. Following operation of the cylinder 30, the link 24 and retaining springs 26, together with the links and retaining spring on the opposite side of the blocks 20, 22, maintain the block 20 in position so that the tube 14A is aligned with the tube 14B or 14C. It will be understood that each of the blocks 20 and 22 contains bores aligned with the respective tubes 14A or 14B and 14C so as to allow free passage of plugs between the tube 14A and 14B or 14C at the switch 16. All of the switches 16 are similar in construction. The switches 18 are also of the same construction, the only difference being the direction of passage of the conveyed plugs.

It will be appreciated that typical plug distribution systems provide for electrical communication links between the distributor and receiver channels. For example, the receiver needs to provide a demand signal for use by the distributor and/or to confirm that plugs are being received (e.g. that no blockage has occurred in the tube extending between the respective distributor and receiver channels). The switches 16 and 18 may provide not only for switching of the pneumatic lines but also for simultaneous switching of the communication lines. Figure 3 illustrates a system including this feature.

The system shown in Figure 3 is similar in construction and operation to that of Figure 1. Four input tubes 102A-D are connected to three output tubes 104A-C by a matrix of tubes 114 including switches 116 and 118. The input tubes 102A-D are connected to distributor channels 106A-D and plug making machines (not shown), and the output tubes 104A-C are connected to receiver channels 108A-C and plug assembling machines (not shown) in the same way as in the system of Figure 1.

Electrical communication lines 140A-D extend from each distributor channel 106A-D, and similar lines 142A-C extend from each receiver channel 108A-C. These lines are interconnected by a matrix of further communication lines 143 and switches 144 which allow communication between any of the lines 140A-D and any of the lines 142A-C. Each of the lines 140 and 142 may itself comprise multiple wires in parallel for relaying multiple signals between the interconnected respective distributor channel 106 and receiver channel 108. Each pneumatic switch 116, 118 has associated with it a pair of electrical switches 144 which are actuated so as to establish electrical connection between the respective distributor channels 106A-D and receiver channels 108A-C which are pneumatically connected. The respective switches 116 or 118 and 144 are mechanically ganged so as to ensure that the electrical and pneumatic connections are always consistent.

The switch 116 shown in Figures 5 and 6 connects an inlet tube 114A to either one of two outlet tubes 114B and 114C. The construction of the switch 116 is similar to that of the switch 16 of Figure 2 and it incorporates a movable block 120 and fixed block 122. However, in addition, an electrical switch 144 is attached to the fixed block 122. The movable block 120 carries an arm 121 which, in the position shown in Figure 5 where the tube 114A is aligned with the tube 114C, actuates a switch lever 146 so as to close (or open) contacts 148 (Figure 6) and establish a connection between electrical lines associated with the tubes 114A and 114C. Thus, the switches 116 and 144 shown in Figure 5 may be those marked 116' and 144' in Figure 3, the switches establishing connections between the inlet tube 102D leading from the distributor channel 106D and respective tubes and lines leading to one of the receiver channels 108A-C. In the configuration illustrated the connections are to the receiver channel 108B.

As the pairs of switches 144 associated with a pneumatic switch 116 or 118 as shown in Figure 3 are always switched together, i.e. one is always open when the other is closed and vice versa, the switch 144 of Figure 5 can (with appropriate contacts) perform the function of both switches 144' shown in Figure 3. Alternatively, an additional switch 144 (not shown) could be connected to the underside of the fixed block 122 as shown in Figure 5 so that movement of the block 120 physically makes the connection for the communication line associated with the tube 114B as well as for the tube 114C. In either case, movement of the

block 120 to its alternate position, with the tube 114A aligned with the tube 114B, disconnects the electrical connection to the line associated with the tube 114C and makes the connection to the line associated with the tube 114B.

An electrical switch 144 may be provided in conjunction with a pneumatic switch 118 in exactly the same way as with a switch 116.

An electrical switch 144 associated with a pneumatic switch 116 or 118 has the additional benefit of being able to signal that the pneumatic switch has physically reached its desired operating position following a change. Of course the electrical communication lines leading to a electrical switch 144 associated with a pneumatic switch 116 or 118 may also conveniently include those carrying the signals for actuating the pneumatic switch (although such signal lines would not normally be switched by a switch 144).

It will be appreciated that electrical communication between a distributor channel 106A-D and a receiver channel 108A-C in the system of Figure 3 involves many switch contacts, failure of any of which may cause a system malfunction. A modified system, in which there are fewer electrical switches, is shown in Figure 4, in which reference numbers similar to those used in Figure 3 have been used for similar parts. In the system of Figure 4 the lines 140A-D and 142A-C are extended to form a matrix and are interconnectable by switches 144 placed at the intersections. Each of the switches 144 is physically ganged with the pneumatic switch 116 or 118 which is nearest to it (as viewed in Figure 4). In this respect note that the switches 116 and 118 which are associated with crossover intersections, e.g. those connected by a curved section of tube 143A, must always be switched together as a pair. It follows that the associated electrical switch 144 could be mounted on either of these paired switches.

Switches 144 may not be located so as to physically interrupt a line extending between a distributor channel and a receiver channel. For example, a switch 144 may be provided in a signal line associated with a control unit, e.g. including a microprocessor, so that the control unit responds to the status of the switch and itself establishes the appropriate communication link.

Any (or all) of the switches 16, 18, 116 or 118 may be replaced by a rotary switch similar to the switch 216 shown in Figures 7 to 9. The rotary switch 216 connects an inlet tube 214A to either one of two outlet

tubes 214B and 214C. The tubes 214A, 214B, 214C correspond respectively to tubes 14A, 14B, 14C and 114A, 114B, 114C and may form part of a matrix of tubes similar to those described with reference to the tubes 14 and 114. The outlet tubes 214B, 214C are attached by way of suitable connectors to one face of a stationary plate 222 which contains bores in alignment with the outlet tubes and passing through the plate to an opposite parallel face. A movable plate 220 is arranged with a corresponding parallel face arranged immediately adjacent said opposite face of plate 222. A rotary actuator 230 arranged on the same side of the plate 222 as the tubes 214B, 214C has an actuating shaft 231 which passes rotatably through a bore in the plate 222 and is fixed to the movable plate at 233.

The inlet tube 214A is attached to the movable plate 220 by a suitable connector and is aligned with a bore which passes through the plate. The bore in the plate 220 and the bores in the plate 222 are arranged equidistantly from the axis defined by the shaft 231. At least the bore in the movable plate 220 is provided with resilient sealing means in the form of an O-ring 235 carried in a groove around its perimeter at its end adjacent the plate 222, so as to provide a pneumatic seal between bores in plates 220 and 222 when these are in alignment. The plate 222 carries electrical proximity switches 244.

In operation, the rotary actuator 230, which is of double acting type, may be operated to reciprocably pivot the member 220 between the position shown in the drawings, in which tubes 214A and 214C are aligned, and a position which is rotated through about 45° in a clockwise direction as viewed in Figure 8, in which tubes 214A and 214B are aligned. The inlet tube 214A may be manufactured from relatively flexible material, e.g. plastics material, to allow movement of its end connected to plate 220 with its opposite end (not shown) fixed. Any of the tubes 14A or 114A may be similarly manufactured.

The electrical switches 244, which may be proximity switches arranged to detect one or more features of or carried by the plate 220, may perform any of the functions of the switches 144. Alternatively these switches may be supplemented by contact switches (not shown) to perform at least some of these functions.

As described, the switch 216 is located between an inlet tube 214A and two outlet tubes 214B, 214C: the switch is equally well-suited for use when the tubes 214B, 214C are inlet tubes and the tube 214A is

an outlet tube. In this latter case, it is preferred that the movable plate 220 is provided with through bores located on each side of the tube 214A such that when tube 214A is aligned with tube 214B tube 214C is aligned with one of the bores and when tube 214A is aligned with tube 214C tube 214B is aligned with the other of said bores. With this arrangement, if plugs are conveyed down the inlet tube not aligned with the outlet tube 214A (usually because of a fault) those plugs exit through the respective bore in plate 220 instead of backing up in the inlet tube and possibly causing a line jam.

Mechanical switching of an appropriate communication link simultaneously with switching of the pneumatic tubes ensures that correctly-controlled transport of plugs occurs between the required distributor and receiver channels following a change of routing. A control system may manage the input and output configurations for the pneumatic tubes from continually monitored information gathered from the equipment linked by the system. Typically this equipment includes one or more plug making machines each associated with a plug reservoir (e.g. Molins Polar), a multi-channelled distributor associated with each plug making machine/plug reservoir, one or more plug assembling machines, and single or multi-channelled receivers at each plug assembling machine. In such a system the information processed by the control system for each item of equipment, and on the basis of which the control system will make subsequent switches of connections, is as follows:

Plug Making Machine:	Address (I.D.)
	Plug type
	Plug rate
	Status (on/off)
Plug Reservoir:	Address (I.D.)
	Plug type
	Fill level
	Status (on/off)
	Plug Making Machine I.D.

Distributor:	Channel I.D. Plug type Plug rate Status (on/off) Plug Reservoir I.D. Tube No. Tube length
Receiver:	Channel I.D. Plug type Minimum rate required Tube No. Tube length Status (run/idle) Demand (on/off)
Plug Assembling Machine:	Address (I.D) Plug type Usage rate

The control system may provide other functions. For example, pneumatic plug distribution systems are sensitive to line air pressure, i.e. a long tube run may require a higher line air pressure. The system may be arranged to calculate the new distance between the distributor and receiver following a changed connection, so as to automatically reset the line pressure to a value appropriate to the distance. The pressure can be set by an electronically controlled regulator at the distributor. The distance may be calculated from information provided to the system relating to locations of the switches and tube lengths between the switches.

In combination with the distance determination, or separately, the system may allow checking that the correct configuration has been achieved following a switched connection. Thus, a single plug could be sent and its arrival at the receiver recorded. If the distance to the receiver is known, the system may determine the average velocity of the plug and readjust the line pressure to compensate for any anomalies. The single plug transmitted may be released through an exit gate at the

receiver, e.g. as disclosed in British Patent Specification No. 2272414.

As a supplement or alternative to distance determination based on input information, a sound pulse could be transmitted down the tube and recorded at the receiver. The transmission time could be used to determine the tube length. A similar system could also feed back information of a blockage in the tube. By detection of an echo it may be possible to determine the location of a blockage. Alternatively, or additionally, a rough estimate can be obtained by switching a connection and testing the new tube path, either with sound or a test plug: this can determine whether a blockage is before or after a switch location. Indication of a blockage may also be provided by one or more strategically positioned flow or pressure detectors along the tube lengths.

Information relating to input and output product changes can be sent to a PC or other programmable processor to record exactly what product was delivered to each plug assembling machine during specified periods. This feature allows tracking of batches of products.

The system of Figure 1 could incorporate the communication links and control system described with reference to any of Figures 3-5.

In the system shown in Figure 6 three pneumatic distributor units C1, C2, C3, each having five channels S, D1, D2, D3 and D4, are linked by pneumatic tubes 60 to six plug assembling machines P1-P6, each of which has receiver units having two channels. The distributor units C1-C3 are each connected to a plug making machine (not shown). The pneumatic tubes 60 leading to the respective machines P1-P6 are shown only for machine P1. The receiver channels in each of the machines P1-P6 are connected to distributor channels in different units. Thus, in the event of a malfunction of one of the units C1-C3 (or of its associated plug making machine) each of the machines P1-P6 should continue to receive plugs through at least one of the tubes 60 connected to it.

The connections between the distributor channels and the machines P1-P6 are as follows:

Machine	Channel 1 connection	Channel 2 connection
P1	C1D1	C2D1
P2	C1D2	C2D2
P3	C1D3	C3D1
P4	C2D3	C3D2
P5	C1D4	C3D3
P6	C2D4	C3D4

In this table C1D1 designates distributor channel D1 in unit C1 etc.

Each of the units C1-C3 consists of a hopper which receives plugs from the associated plug making machine and supplies them to the five distributor channels of the unit. The units may be Molins Pegasus distributor units. Separate two-channel receiver units R1-R3 are respectively connected to the units C1-C3 so that plugs received by the receiver units are delivered to the hopper of the respective unit C1, C2 or C3. The receiver units R1-R3 may be Molins Pegasus receiver units (and may be identical to the receiver units incorporated in the machines P1-P6).

The distributor channel S in the unit C1 is a spare, and is not connected to any tube extending directly to one of the machines P1-P6. It is connected to an input tube 62A of a switch 64A having three output tubes 66A, 68A and 70A. The switch 64A is of generally similar construction to the switches 16 and 116 of Figures 2 and 5 or switch 216 of Figure 7 except that it has three operative positions. The tubes 66A and 68A are respectively connected to one of the receiver channels of the receiver units R2 and R3 associated with the other distributor units C2 and C3. The tube 70A is connected to one channel of a triple receiver unit 72 (which, again, may be a Molins Pegasus unit) connected to feed plugs to a tray filling machine 74. The spare channels S of the units C2 and C3 are connected by way of respective units 62B and 62C, switches 64B and 64C, and further tubes 66B, 68B, 70B, and 66C, 68C, 70C, in a manner which is analogous to the connections for the unit C1.

The system of Figure 10 allows spare capacity from a plug making machine associated with any of the units C1, C2 or C3 to be directed to

supplement the supply at any of the other units. In addition, spare capacity may be directed to the tray filler 74, for onward conveyance of plugs in trays to another distributor unit or plug assembler. Because of the links between the units C1, C2 and C3, the plugs being delivered to these units (i.e. from the plug making machines) must be of the same type. By contrast, in the systems of Figures 1, 3 and 4 different types of plug may be conveyed, as long as they are physically compatible with the tubes and it is ensured that a receiver receives only the correct product for its associated plug assembling machine. It follows that where different types of plug are transported in systems such as that depicted in Figures 1, 3 or 4 certain switch connections must be barred (so as to ensure no mixing of plug types).

The system of Figure 10 may incorporate appropriate communication connections which are switched by the switches 64A, 64B and 64C in the same way as described with reference to the systems of Figures 3-5.

Claims

1. A pneumatic conveying system for rod-like articles, comprising at least one delivery device, at least one receiving device, means defining a pneumatic delivery path extending from said delivery device, means defining a pneumatic receiving path extending towards said receiving device, first switch means for selectively establishing connection between said delivery path and said receiving path, means for establishing communication between said delivery device and said receiving device including second switch means for selectively enabling signal communication in accordance with the status of said first switch means, and means for switching said first and second switch means.

2. A system as claimed in claim 1, wherein said first and second switch means include a common switching element.

3. A system as claimed in claim 1 or 2, wherein said second switch means is associated with electrical communication lines extending between said delivery device and said receiving device.

4. A system as claimed in claim 3, wherein said electrical communication lines include processing means.

5. A system as claimed in any preceding claim, including control means for actuating said switching means in accordance with signals derived in dependence on occupation or passage of articles in the system.

6. A system as claimed in any preceding claim, including at least one further pneumatic path, said first switch means being arranged to selectively establish connection between said further pneumatic path and one of said delivery path and receiving path.

7. A system as claimed in claim 6, wherein said second switch means is arranged to selectively enable communication with a delivery or receiving device associated with said further path.

8. A system as claimed in any preceding claim, including a

plurality of delivery devices and a plurality of receiving devices, a plurality of pneumatic delivery paths extending from said delivery devices and a plurality of receiving paths extending towards said receiving devices, and a plurality of junctions between said delivery and receiving paths including first and second switch means associated with said junctions, and means for operating respective first and second switch means to establish pneumatic and electrical communication between selected delivery and receiving devices.

9. A system as claimed in any preceding claim, including upstream and downstream first switch means arranged in series and associated respectively with first and second pneumatic junctions, including a common second switch means associated with said respective first switch means.

10. A system as claimed in claim 9, wherein said first pneumatic junction includes an input path and at least two output paths, and said second junction includes at least two input paths, one of which corresponds to one of said output paths from said first junction, and an output path.

11. A pneumatic conveying system for rod-like articles, comprising switch means having means defining laterally-spaced passages for articles, means defining a further passage for articles, and operable means for causing relative movement of said means so as to align said further passage with a selected one of said laterally-spaced passages.

12. A system as claimed in claim 11, including an electrical connection associated with said switch means, wherein said operable means is arranged to cause switching of said electrical connection.

13. A system as claimed in claim 11 or 12, wherein said operable means comprises reciprocable means operable between defined positions corresponding to alignment of said third passage with either said first or said second passage.

14. A system as claimed in any of claims 11-13, including

conduit means connected to at least one of said passages, said conduit means being laterally flexible to accommodate movement caused by said operable means.

15. A system as claimed in any of claims 11-14, wherein said means defining a third passage is formed in a reciprocable body constrained to move between positions in sealing engagement with said first and second passages.

16. A system as claimed in any of claims 11-15, wherein said operable means comprises rotary means.

17. A system as claimed in claim 16, including a first member having a first face and at least one of said laterally-spaced passages having an outlet in said first face, a second member having a second face and said further passage having an outlet in said second face, means for mounting said first and second members with said first and second faces substantially parallel and adjacent to each other and for relative rotational movement about an axis substantially transverse to said faces, said operable means including means for moving at least one of said members about said axis relative to the other so as selectively to move said member or members between a first position, in which said respective outlets in said first and second faces are in alignment, and a second position, in which said outlets are out of alignment.

18. A system as claimed in claim 17, wherein said laterally-spaced passages comprise said outlet in said first face and a further outlet in said first face.

19. A system as claimed in claim 18, wherein said further outlet and said outlet in said second face are in alignment when said members are in said second position.

20. A system as claimed in claim 19, wherein said outlets and said further outlet are substantially equidistant from said axis.

21. A system as claimed in any of claims 17-20, wherein at least one of said faces carries sealing means arranged to provide a seal

around the transition between outlets which are in alignment.

22. A system as claimed in any of claims 1-9, wherein said first switch means includes a system as claimed in any of claims 10-21.

23. A pneumatic conveying system for rod-like articles, including a plurality of delivery devices, a plurality of receiving devices, means defining paths for pneumatic conveyance of articles between each delivery device and at least one receiving device, and further means for conveying articles pneumatically between at least two delivery devices, whereby the supply of articles at one delivery device may be supplemented by receipt of articles from another delivery device.

24. A system as claimed in claim 23, further including switch means for selectively connecting the output from a delivery device either to a receiving device or to another delivery device.

25. A system as claimed in claim 24, wherein the switch means includes a system as claimed in any of claims 10-21.

26. A system as claimed in claim 24 or 25, wherein the switch means is connectable to a receiving device which loads articles into containers.

27. A system as claimed in any of claims 23-26, including at least two groups of delivery devices, with each group connected to a different source of articles.

28. A system as claimed in any of claims 23-27, including at least two groups of receiving devices, with each group associated with a different machine for processing articles received from said receiving devices.

29. A system as claimed in claim 28 when dependent on claim 27, wherein the receiving devices in each group are connected to delivery devices in different groups.

30. A system as claimed in any preceding claim, including

means for determining the length of a pneumatic conveying path in the system and controlling the supply of conveying air in accordance with said determination.

31. A system as claimed in claim 30, including means for adjusting the pressure of conveying air on determination of a path length change for articles.

32. A system as claimed in claim 30 or 31, further including control means for determining passage of articles in the system, said control means including means for storing parameters associated with the system, wherein the path length determination is made in accordance with information stored by said storing means.

33. A system as claimed in any of claims 30-32, wherein the path length determination is carried out by transmitting a sound along the path and determining the path length from receipt of the sound (or an echo or other related signal) after passage along the path.

34. A method of determining a path length for rod-like articles in a pneumatic conveying system, including the step of transmitting a sound along the path and determining the path length from receipt of the sound (or an echo or other related signal) after passage along the path.

Fig.1.

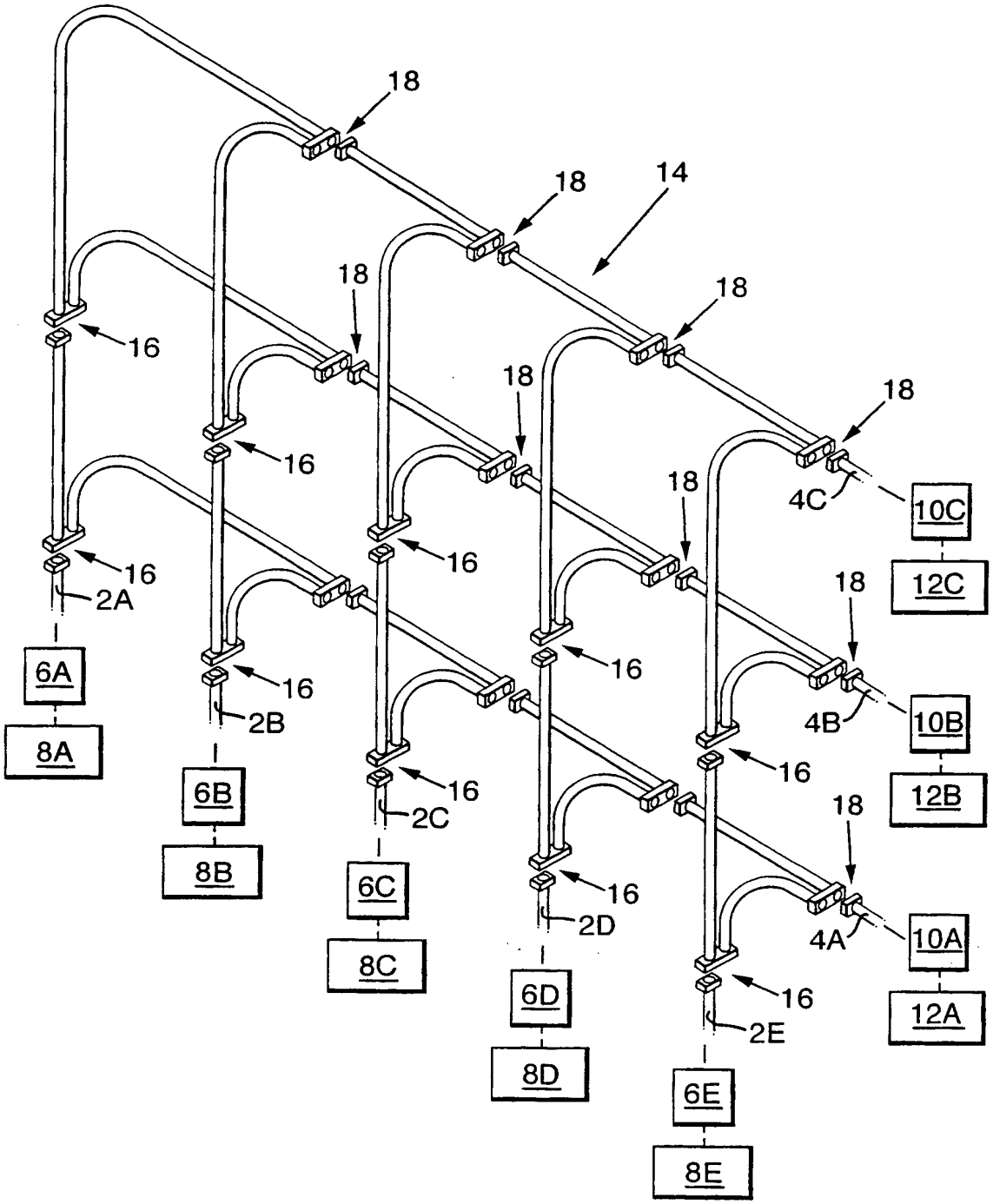
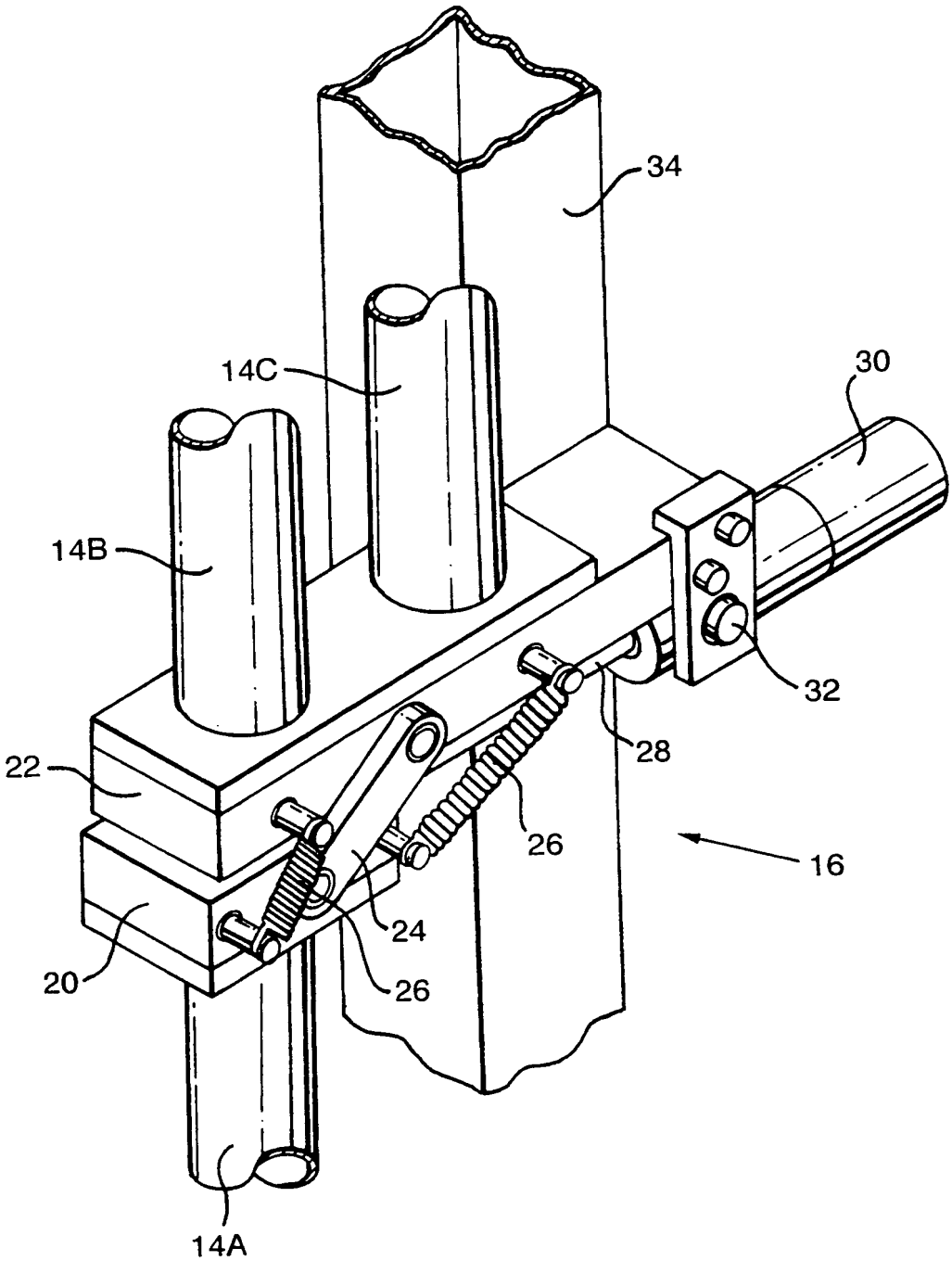


Fig.2.



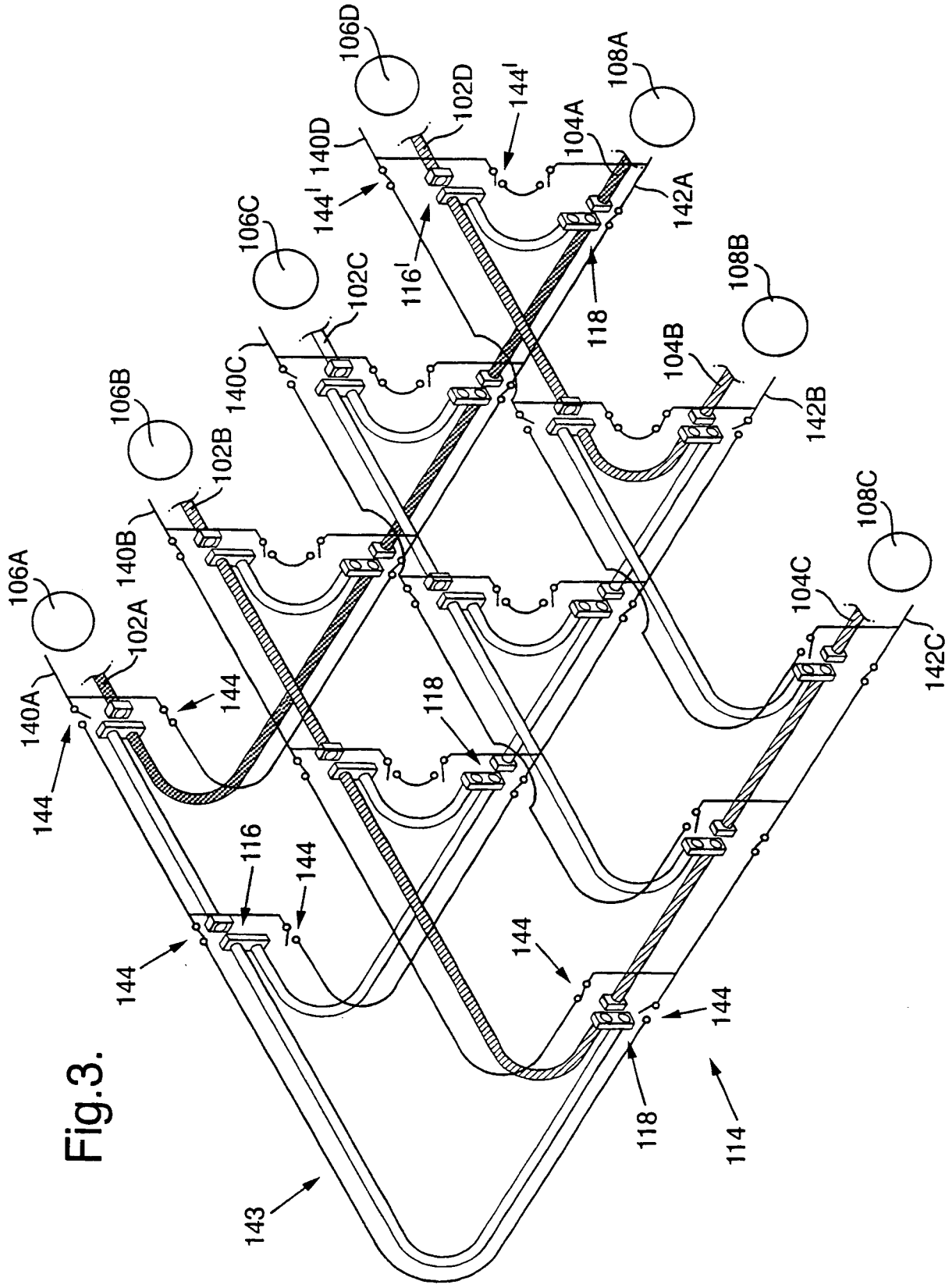


Fig.3.

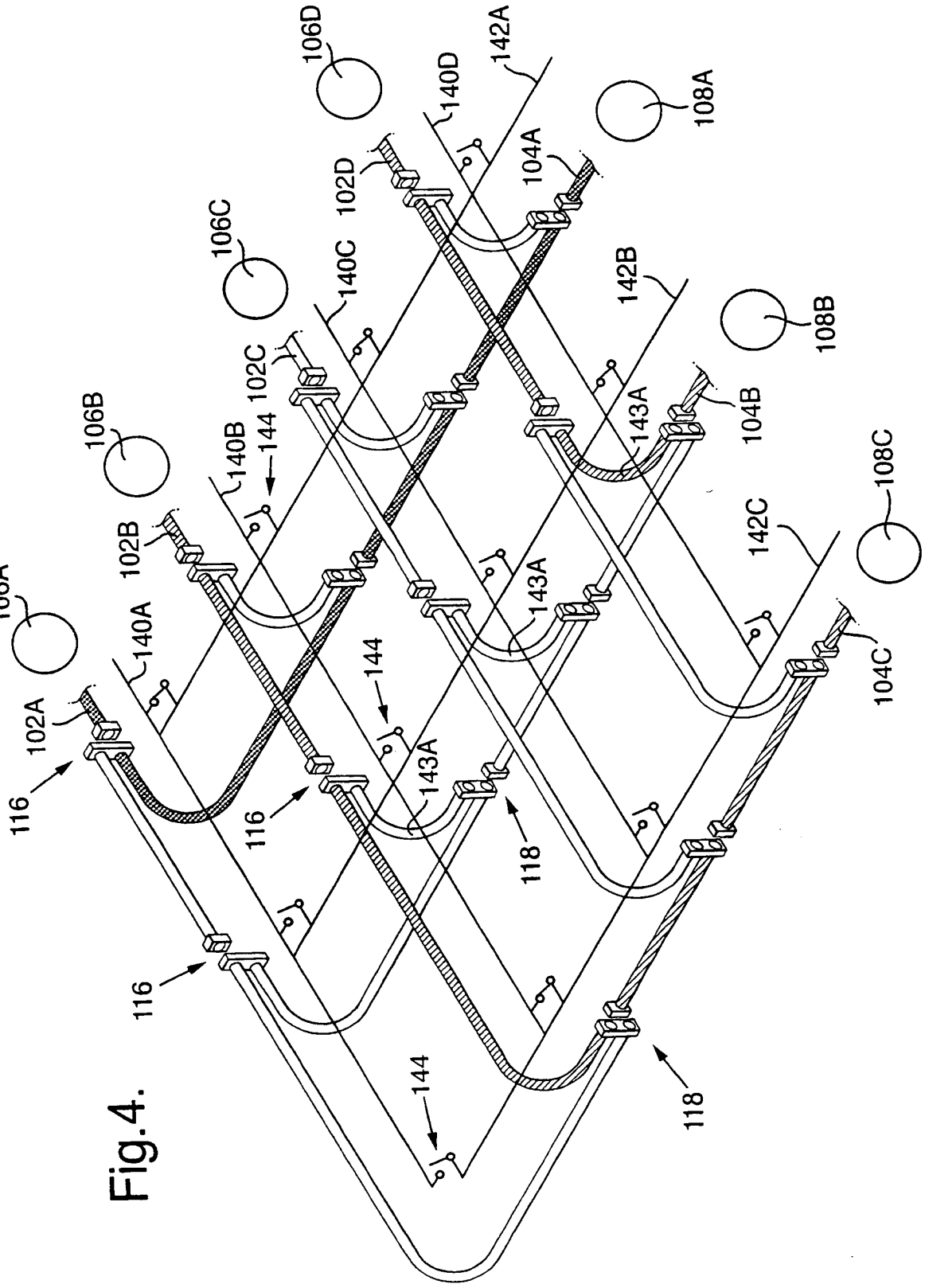


Fig.4.

Fig.5.

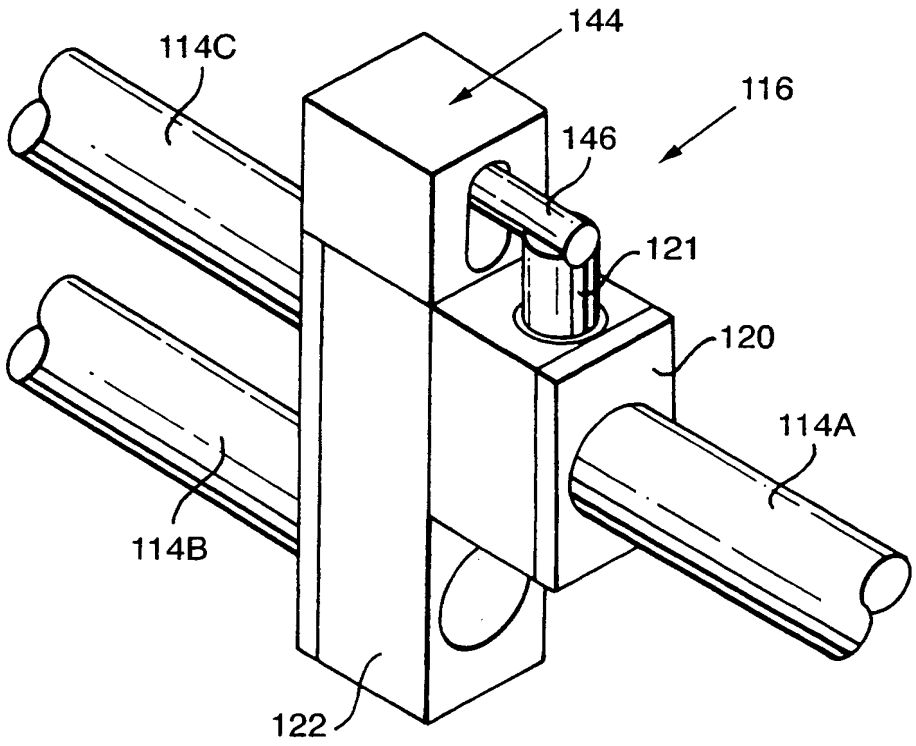
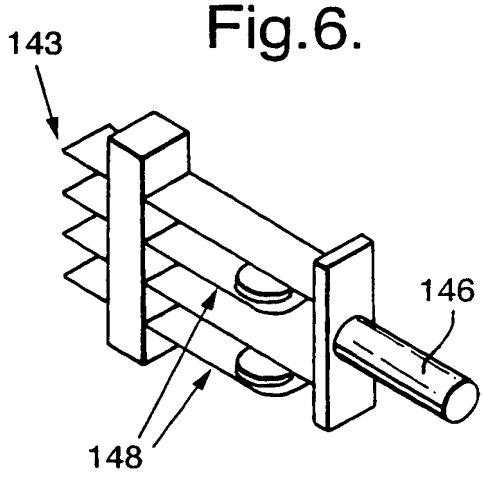


Fig.6.



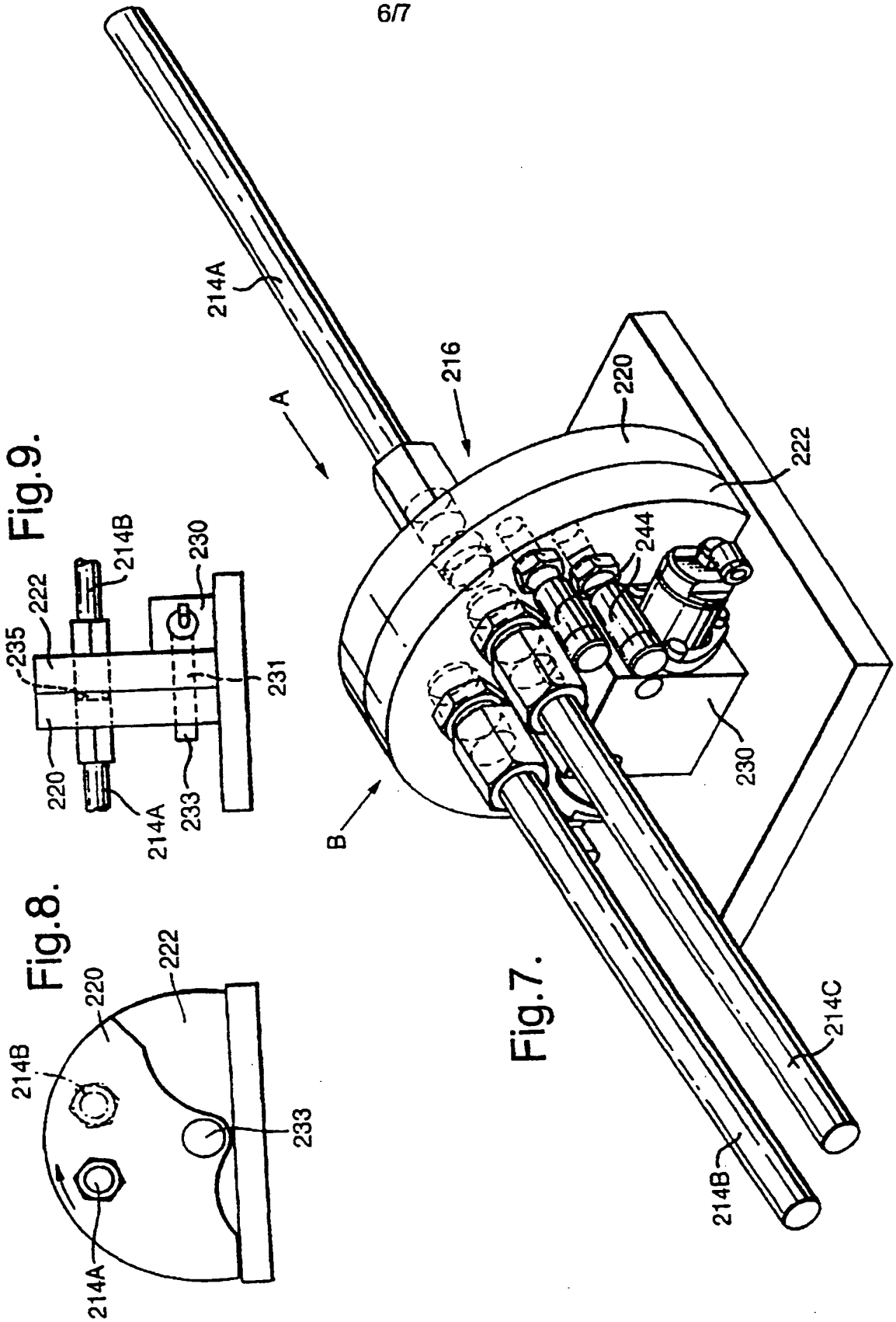
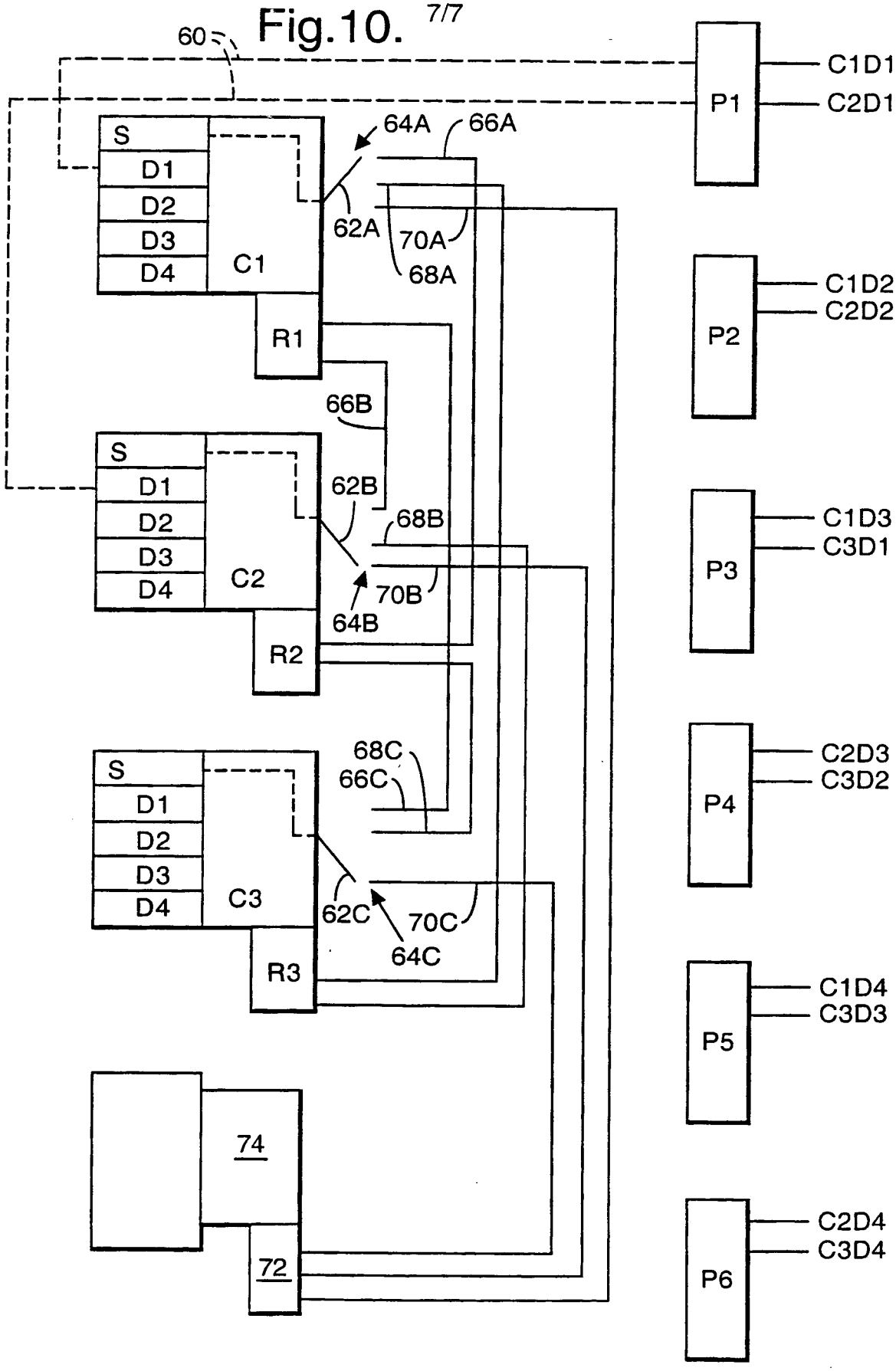


Fig.7.

Fig.8.

Fig.9.

Fig.10. 7/7



INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/GB 98/03276

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A24C5/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A24C B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 595 025 A (WAHLE) 17 June 1986 see column 28, line 31 - column 32, line 65; figures 8A-13	11-16
A		1,5,6,8, 23
A	WO 97 16365 A (FABRIQUES DE TABAC REUNIES S.A.) 9 May 1997 see the whole document	1,8-11, 23,24
A	WO 89 01130 A (BODE) 9 February 1989 see abstract	34

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 March 1999	10/03/1999

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

...nformation on patent family members

Inter ...onal Application No
PCT/GB 98/03276

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4595025 A	17-06-1986	DE 3335955 A	26-04-1984
		GB 2132871 A,B	18-07-1984
		JP 59098674 A	07-06-1984
WO 9716365 A	09-05-1997	CN 1201433 A	09-12-1998
		EP 0865396 A	23-09-1998
WO 8901130 A	09-02-1989	AU 2315988 A	01-03-1989